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Submarine Geological Study of the Bottom Sediments of the Adjacent Seas of the Japanese Islands with Special Reference to the Distribution of Organic Matter in Sediments*

By

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Abstract

Organic matter content in the marine sediments is related to both the sediment characteristics and the morphological features of the floor. Organic matter content is closely related to the grain size composition of the sediments, and, in the case of the area of slow or too rapid deposition of detrital sediments, it is low in all types of sediments. Thus the organic matter distribution in sediments depends partly upon hydrodynamic situations and partly upon conditions which affect the preservation of organic matter.

The concentration and composition of organic acids in the sediments of Lake Biwa vary with the depth from the surface of sediments. On the other hand, there are some differences in composition of organic acids in the sediments of each station of the sea off San'in district.

Introduction

Geologically and sedimentologically it is interesting to discuss relationship between marine environment and the quantity of organic matter that has accumulated on the sea floor under various conditions. From this viewpoint, a knowledge of the distribution of organic matter in sediments have been studied by a number of workers (TRASK, 1932, 1939; REVELLE and SHEPARD, 1939; EMERY and RITTENBERG, 1952; EMERY, 1960; NIINO and EMERY, 1961; BORDOVSKIY, 1965). The writer intends to study the distribution of organic matter in the sediments of the adjacent waters of Japan. In the present paper, the bottom sediments of Japan Sea off San'in district, Suruga Bay, Osaka Bay and Tanabe Bay have been examined for organic matter content and for other characteristics.

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Method

Sampling

Japan Sea off San'in district: A number of bottom sediments were collected from the area off Tottori Prefecture by the writer on board the surveying ship Daisen of Tottori Prefectural Fishery Experimental Station in September and October, 1960. The sediments were collected by a dredge. These samples were designated as Series D samples (Fig. 2).

Seven bottom samples (K-17～K-23) were collected from the area west of Oki Islands by the writer and other workers on board the surveying ship Kaiyô of Hydrographic Department of Japan on July 14 and 15, 1962. Two samples (K-17 and K-18) were collected by a dredge and the other by a core sampler. These samples were stored at low temperature. A number of bottom sediments were collected from the area off San'in district by member of Hydrographic Department on board the above ship in June and July, 1962, which were dried and stored at room temperature. These samples were designated as Series K samples (Fig. 1).

In August, 1965, a number of bottom samples were obtained from the Yamato Bank, the area near Takeshima Island and several other locations by the surveying ship Meiyô of Hydrographic Department. These samples were designated as Series T and M samples (Fig. 1).

Suruga Bay: The field survey and the sampling of sediments in Suruga Bay were undertaken by the writer together with other workers on board research ship Tanseimaru of the Ocean Research Institute, University of Tôkyô during the periods from March 23 to 30 and from June 9 to 11, 1965. A number of samples were collected by a dredge, and designated as Series TSD and TSC-D samples. Sediment core samples were obtained by a gravity corer, and designated as Series TSC samples. The samples collected by a sledge trawl were designated as Series TSB samples. The samples for organic matter analysis were stored at $-25°C$.

Tanabe Bay: The sampling of sediments was undertaken on August 8, 1965 by the writer on board the research boat of Marine Biological Laboratory of Kyôto University. Eighteen samples from 25 locations were collected by a snapper sampler. The samples used for organic matter analysis were stored at low temperature. The sampling locations and chart which was given by Seto Marine Biological Laboratory are shown in Fig. 7.

Osaka Bay: The sampling was undertaken by the writer on board the surveying ship Meiyô on August 25, 1965. Twenty-two bottom samples by a dredge and nine sediment core samples by a gravity corer were obtained (Fig. 8). The samples used for organic matter analysis were stored at low temperature.

Grain size analysis

Each samples was analyzed mechanically to obtain a curve showing the weight distribution as a function of the logarithm of particle size. Sieving techniques and pippet methods were applied to sand and mud fractions respectively. Cumulative curve was plotted on graph, and the phi median diameter, phi mean diameter, phi deviation measure and phi skewness measure of each samples were determined by Inman's equations (Inman, 1952). These measurements of Series K samples were made using the results of the grain size analysis by Satô (Satô, 1964). For the samples of Suruga Bay, approximate values obtained from the unpublished data of Shiki and the writer are given in present paper.

Chemical analysis

The quantity of organic matter may be estimated in various ways. Analysis of organic carbon by combustion is difficult and time consuming, and analysis by titration is subject to error. Nitrogen is a good index of the organic matter content of the samples, although some workers do not consider nitrogen content as an adequate measure of organic matter because of the existence of a great spread in the ratio of carbon to nitrogen. In this study, determination of nitrogen by Kjeldahl analysis has been used. The amounts of nitrogen are given as mg nitrogen per g dry weight of sediment.

The weight loss by ignition has been measured to estimate the approximate organic matter content of the bottom sediments. The COD of samples has been also determined to estimate the quantity of organic matter.

Organic matter in Sediments

Japan Sea off San'in District

The submarine geology of the sea off San'in district, the southern part of Japan Sea, has been studied by several workers (Niino, 1948; Sato, 1964). The submarine topography of the area is shown in Fig. 1. There is a series of islands and banks, and a submarine peninsula spreads northerly for 150 km off Tottori

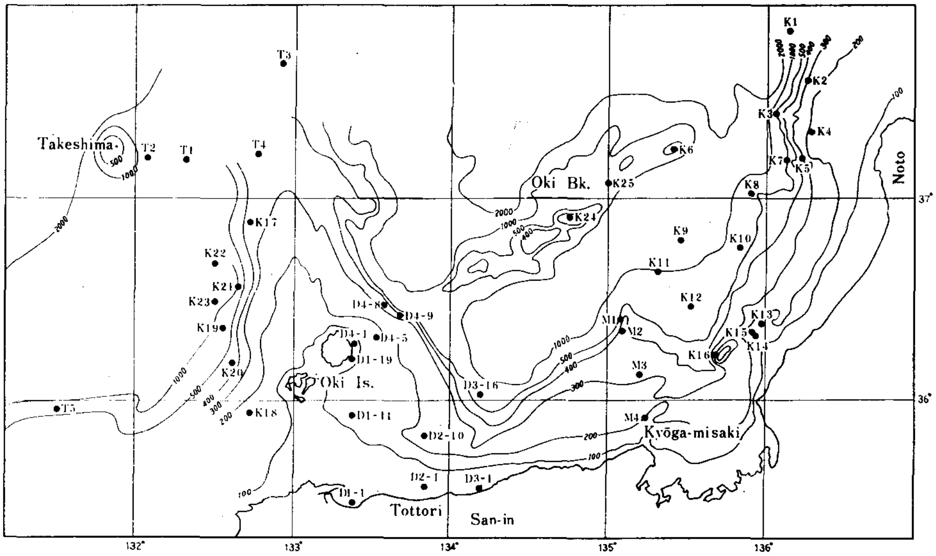

Fig. 1. Map of surveyed area. Contours adopted from SATO (1964) and Chart No. 7054.

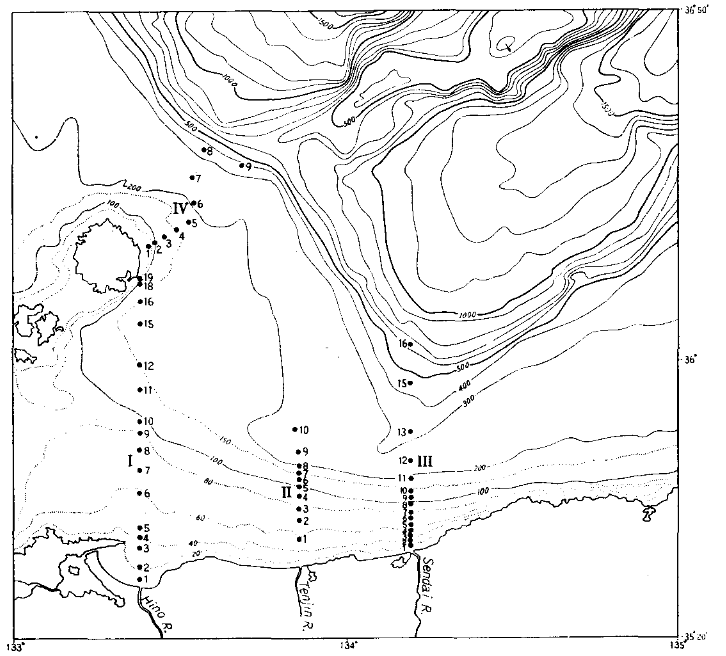

Fig. 2. Map of surveyed area.

Prefecture. The continental shelf off San'in district has a deeper edge of 200–300 m deep and a wider width of than the ordinary shelves along the Japan Sea coast of the Japanese Isalnds (SATO, 1964). In the area from Oki Bank to San'in shelf, there is a remarkable deep-sea plain, 900–1700 m deep (SATO, 1964). The data concerning the bottom sediments are given in Tables 1$\sim$3.

The shelf sediments off San'in district are divided into three zones as following.

1) Sediments of bay off Hino River mouth are constituted by well sorted very fine sand. Sand content constitutes over 80 per cent and clay content only a small per cent. Organic matter is not abundant. The low content of organic matter in those sediments shows that organic matter is not accompanied with very fine sand during transportation processes. Organic matter decreases rapidly in the coarse sediments of the outside area of this zone.

2) Shelf sediments off Tottori Prefecture are composed mainly of well sorted sand which contains only a small amount of organic matter. Low organic matter content in the shelves can be ascribed, as is discussed in the following chapter, to winnowing agency and a very slow rate of deposition of inorganic detrital sediment.

3) The sediments of shelf margin, 100 to 150 m in depth, is characterized by fine sand. Organic matter content is very low in this zone as well as in the inside area of this zone. These sediments had been probably accumulated by hydrodynamic action in the past. Low organic matter content can be ascribed to the absence of finer fractions of the sediments (which incorporate organic matter,) due to hydrodynamic activity.

In the outside area of this zone organic matter content increases rapidly with the increase of finer fractions of the sediments. The approximate 200 m depth can be considered as a transition zone between sandy and muddy areas, or between low and high organic matter content areas.

As described above, the shelf sediments off Tottori Prefecture change, with the increase of depth and distance from the shore, from coarse sand to medium sand, fine sand and silt.

Organic matter content increases rapidly in the shelf margin and increases progressively with the decrease of grain size. Rapid and progressive increase of organic matter in the zone deeper than 200 m may show accumulation of suspended matter. The sediments of shelf margin, deeper than 200 m, is characterized by sandy mud or mud, which consists mainly of silt. The sorting becomes poorer in this zone and sometimes the sediments contain some plant fibers. The organic matter content tends to increase with the increase of silt content.

Organic matter content in the sediments of shelf margin off Sendai River mouth is lower than that of other areas, but the mud content is high. On the other hand, these sediments show frequency curves which are not simple. These features may indicate that the conditions of deposition in the area developed by these sediments differ from those of other areas.

The bottom sediments off Kyôgamisaki are characterized by very poorly sorted mud which has high clay content. These sediments contain plant fibers or fragments that were probably derived from land. Topographically the shelf off Kyôgamisaki has an edge 400 m deep and 60 km wide (SATO, 1964). In the area deeper than 200 m, the sediments, however, show the characteristic of the slope sediment. Namely, the sediment is characterized by very poorly sorted sandy mud in the zone 200 m deep, and by very poorly sorted mud in the zone deeper than 300 m. Organic matter content in this area is higher than that of other areas off San'in district. Its content increases with depth, and with the increase of clay content.

In the area west of Oki Islands, the sediments of submarine peninsula consist of silty mud. In this area organic matter content is high on the slope, especially on the foot of the slope. It is remarkable that the organic matter content is high on the submarine peninsula far north of Oki Islands. It may be considered that this high content of organic matter depends upon the rapid accumulation of sediments, but such an environment of deposition is contradictory with the topographic condition of this area.

The Oki and Yamato Banks are large submarine banks. According to SATO (1964), the deep continental shelf and the top of these banks were results of submargence since the maximum lowering of sea level in Würm Glacial Stage. The sediments of these banks are characterized by well sorted medium-very fine sands. Organic matter content is low on the top and sides of banks (Fig. 3). This should

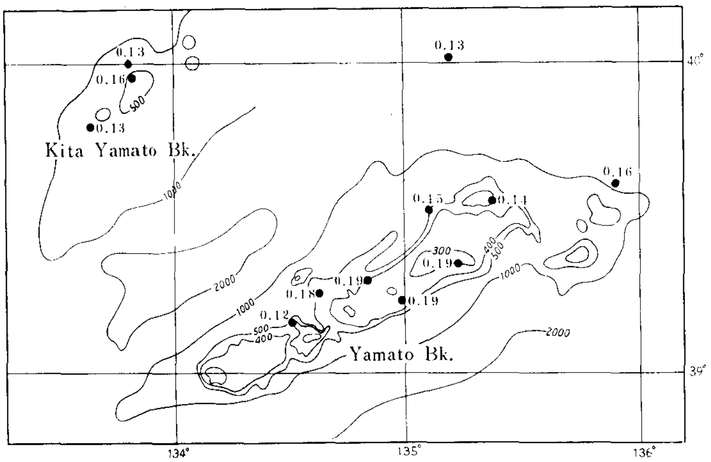

Fig. 3. Nitrogen content in the sediments of Yamato Bank (% N). Contours adopted from SATO (1964).

be attributed to winnowing agency and oxidation of organic matter related with very slow rate of deposition of inorganic sediments.

The bottom sediments of deep sea plain between Oki Bank and San'in Shelf are characterized by muddy sand or silty mud. Organic matter content is low in this area. As noted above, the organic matter content is related, usually, to mud content (Fig. 4). The scarcity of the organic matter in the sediments in this deep-sea plain may be ascribed to the slow rate of deposition of detrital sediments in this area. It is considered that only a small quantity of sediments reach there beyond the shelf and slope.

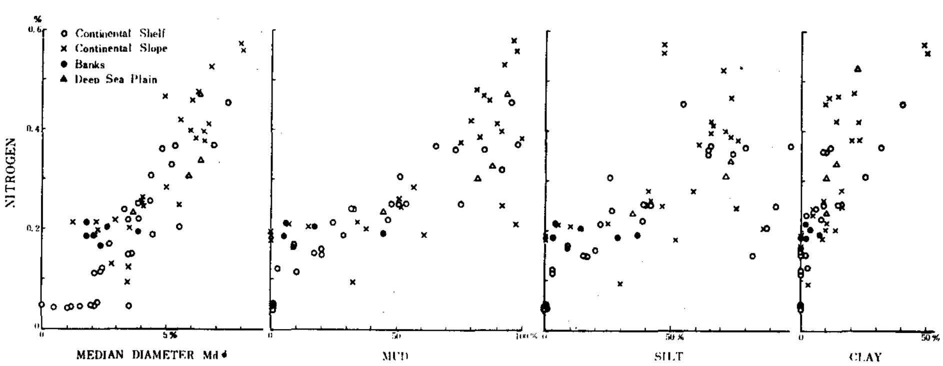

Fig. 4. Relationship between Kjeldahl-N and $Md\phi$, mud, silt and clay in the sediments off San'in district.

The sediments on the topographic mounds near Takeshima Island are characterized by well sorted medium~fine sands which contain abundant foraminiferal tests, and are low in organic matter content.

Suruga Bay

Suruga Bay is bordered on the east by the Izu Peninsula and on the west by plains and hills. Several large rivers, the Oi, Abe, and Fuji Rivers empty into the bay from the western and northern direction. The continental shelf develops well except at the inner part of the bay, and its break is about 200 m deep below sea level. The shelf becomes narrow and its break becomes shallow toward the north. Northern Seno Umi and the outer bank rise at the center of the bay to about 50 m from the surface. A canyon-like depression runs from north to south along the Izu Peninsula (Fig. 5). The data concerning the sediments of Suruga Bay are given in Tables 4 and 5.

In the core samples from the area off the Oi River mouth, plant fragments are found in the mud under sand layers at the depth of 30 to 40 cm. The upper 20 cm of the sediment core off Osesaki also contains plant fragments. The nitrogen

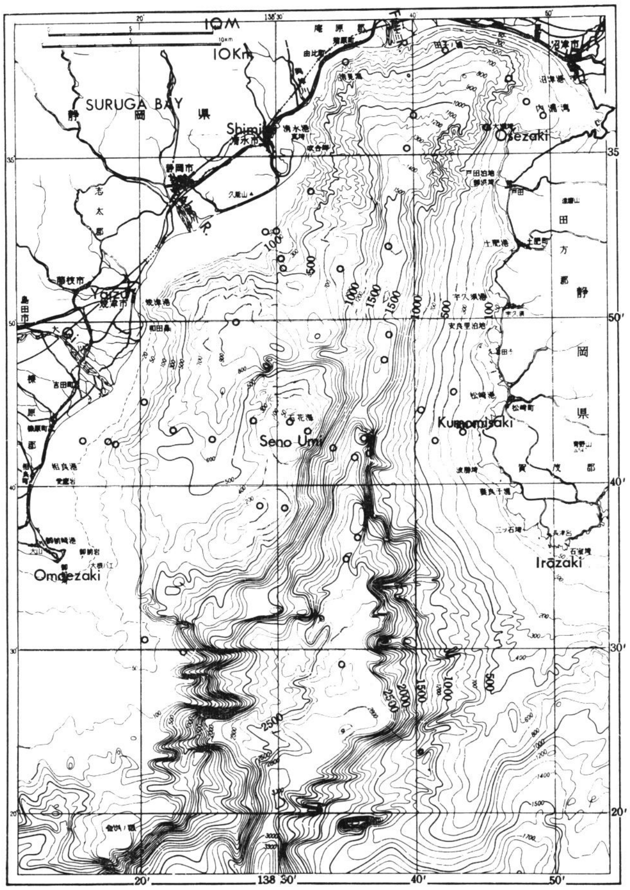

Fig. 5. Map of surveyed area. Contours adopted from Chert No. 7001.

content of the sediment decreases to about half of its value within the upper 50 cm of the sediment core off Osesaki, whereas a slower rate of decrease was observed in the core off the Oi River mouth.

The characteristics of the sediments and the environments of deposition differ from place to place in the bay. Four distinct sedimentary environments are observed: the west part of the bay, the easst part of the bay, the banks, and the inner part of the bay.

1) Banks: The basement of the banks is composed of soft sandy mudstone, which may be reffered to the Neogene Tertiary or Pleistocene. At the east side of the Seno Umi Bank the rock is exposed, showing that the rate of accumulation is negligible at this place and probably very slow at other places near this location. The rock is heavily bored by animals. These materials are covered partly by layer

of mud and partly by gravels embedded in sand and mud. The gravels are composed of hard sedimentary rocks, igneous rocks, and the soft sandy mudstone. The soft mudstones are probably derived from immediately underlying rocks by submarine weathering or perhaps by former erosion. All gravels are considerably water-worn and some of them have an organic encrustation. The soft mudstones are bored heavily by burrowing activity of organisms.

Organic matter content is low in the sediments of the banks. Coarse sediments of the bank have very low nitrogen content. Mud has relatively high nitrogen content. This value, however, is considerably lower than that of the mud of other places in the bay. In the sediments of the east side where the rate of deposition is presumed to be slow, the organic matter content is low in value, in comparison with that of the west side of Seno Umi Bank.

2) West part of the bay: Nearshore is characterized by well-sorted fine sand. This sand develops along the coast as a result of the agency of both the orbital current and the longshore current under abundant supply of detrital sediment from river mouth. In this situation, the mud fraction, which contains the organic matter, is put into suspension and scattered to the zone beyond the limit of wave disturbances on the bottom. The low organic matter content in these sediments is therefore ascribed only to the winnowing agency by current action.

In the muddy area of offshore, organic matter content is high. On the other hand, it is low in the transition zone between sandy area and muddy area, where sedimentation seems rather rapid. In this case, the effect of dilution may be rather an adequate explanation.

3) East part of the bay: Nearshore sediments of the southwest coast of Izu Peninsula are characterized by well-sorted medium and fine sand. In these sediments organic matter content is low.

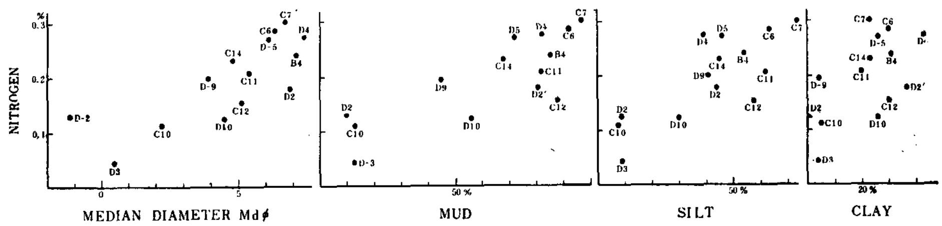

Fig. 6. Relationship between Kjeldahl-N and $Md\phi$, mud, silt and clay in the sediments of Suruga Bay.

The area outside nearshore sands is characterized by poorly sorted sand and silt or sand and mud. The sediments tend to become finer with the increase of depth and distance from shore. Organic matter content becomes larger in the sediments of muddy area and increases towrd the bottom of the "canyon" running along the west coast of Izu Peninsula. It shows the highest value on the bottom of the "canyon" except at St. C-12, east of Seno Umi Bank.

The bottom of the "canyon" is floored by poorly sorted muds. The surface sediments tend to decrease in Md ϕ toward the south. Sand content of the sediment tends to increase toward the south, and silt content to decrease, on the contrary. Clay content is almost similar along the "canyon" axis. From several locations in the mouth of the "canyon", pebbles which consists of water-worn or angular hard sedimentary rocks and igneous rocks were collected. Organic matter content clearly decreases down the "canyon" axis, and unusually low value is observed in the St. C-12.

The decrease of organic matter content of the bottom sediments down the "canyon" axis can be ascribed to several reasons. One is the more abundant accumulation of detrital sediments which preserve organic matter and of organic matter itself in the northern part. It should be noticed that abundant plant materials were also obtained from the bottom east of Seno Umi Bank. Furthermore, the thin layers containing plant fragments intervene in the sediment core of St. 6 (station in the bottom of the "canyon" northeast of Seno Umi Bank). These indicate that plant materials from land play rather an important role as a source of organic matter in sediments. The supply of these plant materials, which had probably been carried from the north along the bottom of the "canyon", is presumed to be more abundant in the northern part.

The existence of hydrodynamical agency can be suggested as an another factor determining the distribution of organic matter in the bottom sediments along the "canyon" axis. Nitrogen content decreases with the decrease of silt content and with the increase of sand content, toward the mouth of the "canyon". Conceivably a part of organic matter is accompanied with mud fraction of the sediments. Accordingly, it can be considered that there is a sort of hydrodynamic agency on the bottom along the "canyon" axis. As mentioned above, the thin laminae containing black coloured fine grains and laminae containing plant debris intervene in the sediment core of St. 6. The sequence of different types of laminae is probably a hydrodynamical result of intermittent deposition.

The unusually low organic matter content of St. C-12 that is located in the east of Seno Umi Bank in the bottom of the "canyon", can be ascribed to several reasons. One is the very slow rate of deposition in this place. In this case it is natural to consider that there is an agent which tends to keep the floor clear of sediments. The "canyon" shows V-shape in cross section view there, and its bottom has a steeper inclination than the upper stream.

In the place immediately southeast of this station (foot of east side slope), the sediment shows great variety in accordance with the depth of burial; at surface it is composed of poorly sorted mud, and, at about 10 cm below the surface, the sediment consists of mud containing pebbles, which consist mainly of soft mudstone similar to the basement of bank. The sediment shows at surface a rather high organic matter content, which decreases greatly with the depth from the surface of the sediment (Table 5). The high concentration of organic matter in surface sediment may indicate a high accumulation of the sediment.

Further down the "canyon" axis, the sediments consist of coarser materials as previously noted. Sledge trawl operated by Dr. HARADA showed that the area, which is immediately down the "canyon" from St. C-12, is nearly barren of life. These facts may indicate that the area of mouth of "canyon" is in a unstable state.

4) Inner part of the bay: The sediments are characterized by poorly sorted mud. In this part, organic matter content is of the highest value. Relatively low quantity of organic matter content in some sediments of this part is probably attributed to the coarser size of sediment.

Tanabe Bay

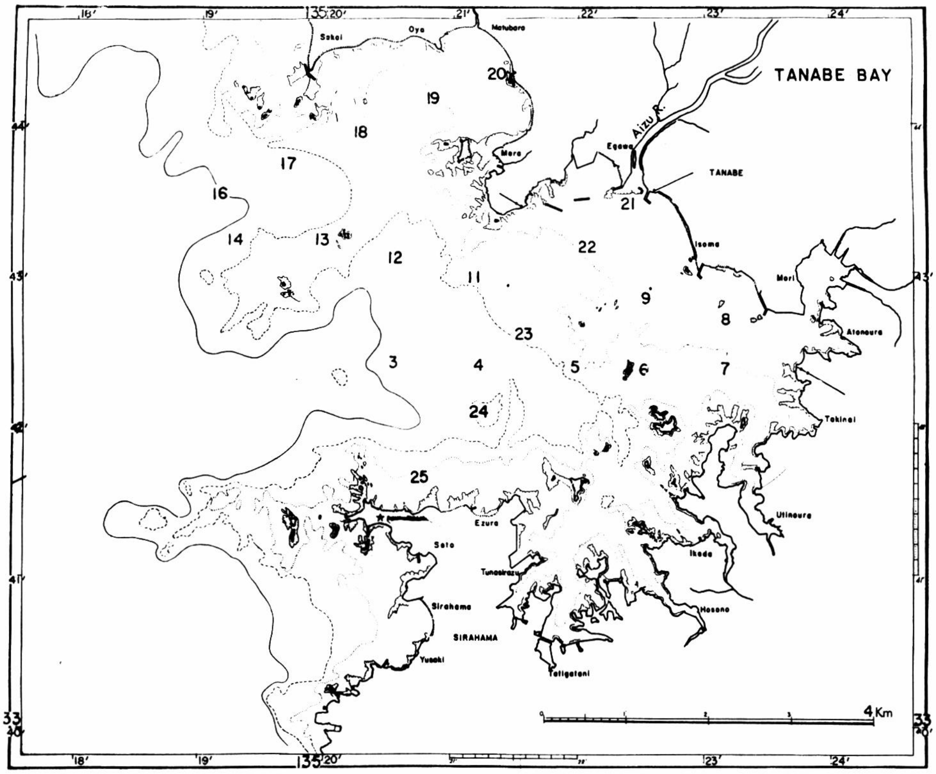

Fig. 7. Map of surveyed area.

Tanabe Bay is a bay existing on the southwest coast of the Kii Peninsula, and is connected with the Pacific Ocean at the western bay mouth. The bay is quite shallow and generally does not exceed 30 m. The southern half of the bay is bordered by a complex coast line rich in arms. The sole large river, the Aizu River, empties into the bay from the north.

The data concerning the bottom sediments are given in Table 6. Content of nitrogen ranges mostly from 1.3 to 1.7 mg per g dry weight of sediment at the outer part. In the sediment of the central and inner part of the bay, it is usually between 1.5 and 2.4 mg per g dry weight of sediment. Namely, its content was found to be higher in the central and inner part of the bay, to become smaller in the outer part.

Osaka Bay

Osaka Bay is an ellipsoidal bay with the long axis trending NE-SW, and is connected with the Pacific Ocean by Kii Strait and with Seto Inland Sea by Akashi Strait. The bay is shallow and genrally calm. The sole large river, the River Yodo empties into the bay from the northeast. The northeastern half of the bay was surveyed.

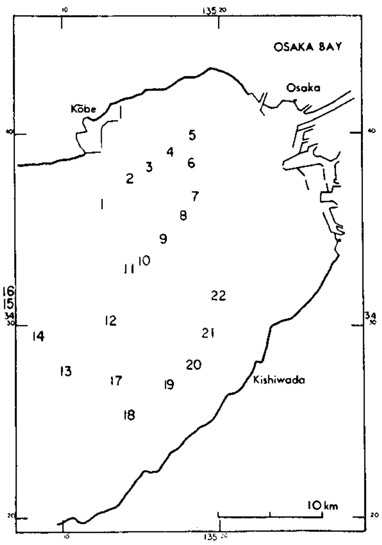

Fig. 8. Map of surveyed area.

The sediments obtained from the surveyed area consisted of mud except for those from Stations S-15 and S-16 which consisted of gravel and sand. The sediments from the northern part of the bay were blackish grey or dark greenish grey in wet condition. The sediments off the southern coast of the surveyed area were greenish grey in colour. In the central part of the surveyed area, the muds were bluish grey in colour but had brown oxidizing surface layer. The sediments at Stations S-3～7 and S-9 had an offensive odor. The top layer, about 20 cm thick, of most cores was soft, and that of the sediments at Stations S-1～9 and S-20 was soupy.

The data concerning the nitrogen content are given in Table 7. The nitrogen content of surface sediment was found at the minimum to be 1.3 mg per g dry weight of sediment in the central part of the bay, and at the maximum to be 8.5 mg per g dry weight of sediment at Station S-9. A higher value was observed in the sediments off Kishiwada, Osaka and Kôbe City, and a lower value in those of the central area.

Vertical distribution of nitrogen content and some other characteristics of the sediments are given in Table 8. The nitrogen content shows a downward decrease. Within the first 50 cm or so of each core, the nitrogen content decreases its value to about 2 or 2.5 mg per g dry weight of sediment. It seems that nitrogen content rapidly decreases its value to about 2 or 2.5 mg per g dry weight of sediment within the upper 50 cm, and decreases slowly in greater depth.

Consideration on distribution of organic matter in sediments

Based on the data concerning the distribution of organic matter content in areas of different types of environments, the causes of variations in feature of the distribution of organic matter in marine sediments can be considered.

The data concerning the banks show that the organic matter content is low in all types of bank sediments trated here. It is generally held that production is greater in areas of banks. It is because around the banks the ascending currents develop. Nevertheless, organic matter content is remarkably low in the sediments of such areas. This feature can be ascribed to several reasons. One is that organic matter is easily winnowed away incorporated with mud by hydrodynamical activity. However, in the fine sediments of the banks, as in the mud of Seno Umi Bank for example, organic matter content is rather small in comparison with that of nearshore fine sediments. Next, the very slow rate of deposition of inorganic sediments, which protects the organic matter from intensive oxidation by burial and reduces the destruction by bottom organisms, is considered as another reason. The low content may also be due to the more active consumption by organisms on the banks.

In the nearshore coarse sediments, organic matter content is low in general.

Several reasons can be considered in explaining the low values. One is hydrodynamical agency. This is due, naturally, to the fact that plenty of organic matter is incorporated with fine grained mineral particles, or that organic detritus behaves in a manner similar to finer sediment particles owing to similarity in their moving velocities. Other reasons can also be considered. For example, inorganic detrital sediments which accumulated under very rapid deposition dilute the organic matter. On the contrary, too slow rate of deposition of nondecomposable materials may result in the extensive oxidation and decrease of organic matter. For example, in the case of bay sediments off Hino River mouth, too slow rate of deposition can be hardly cobsidered. Dilution effect seems reasonable to explain the low organic matter content in these sediments. However, considering the very good sorting and the low content of mud fraction, hydrodynamic agency is more probable as a main reason determining the low values of organic matter content in these sediments.

The low value of organic matter content in the fine sand which develops along the coast of Suruga Bay offers another good instance to support the hydrodynamical reason. These sediments occur as a result of separation of mud from sand due to hydrodynamical activity under abundant supply of detrital sediments from river mouths. Low organic matter content must be due to scattering of suspended materials which acompany the organic matter.

In general, the low organic matter content in nearshore well sorted fine or very fine sand is ascribed firstly to hydrodynamical agency.

Organic matter content increases rapidly in the area of mud beyond the area of nearshore coarse sediment. This increase can be attributed to the separation of mud fraction from coarse materials by hydrodynamic activity. The mud fraction of the sediment, which accompanies organic matter, is put into suspension and scattered offshore by the water exchange. Thus organic matter content increases abruptly in the area bepond the limit of wave disturbances on the bottom where mud fraction of sediment accumulates. In nearshore area, organic matter content increases with distance from shore, and is highest on the slopes. This feature can be ascribed to several reasons. One is the abundant accumulation of suspended matter in the areas of abundant organic matter content. Another is the optimum rate of accumulation of detrital sediments, which tend to favor the preservation of organic matter in such areas. Dilution effect of nondecomposable materials on organic matter must be considered here.

Low organic matter content in the shelf sediments can be ascribed to two reasons. One is the very slow rate of deposition of detrital sediments on the shelf. Another is the hydrodynamical activity. In the shelf off Tottori Prefecture, it is held that well-sorted fine sand in the shelf margin had been accumulated by hydrodynamical activity in the past. Hence low organic matter content in these sediments due to both the hydrodynamical activity in the past and to the very slow rate of deposition. In the zone beyond the shelf margin, organic matter content increases progressively seaward in accordance with the increase of mud fraction. The degree of sorting also becomes poor with the increase of mud content. These features indicate that the suspended materials, which accompany the organic matter, make their way across the shelf. Namely, it is considered that a sort of hydrodynamical agency like winnowing, is going on on the shelf. The high mud content and the high organic matter content in the shelf sediments off Kyôgamisaki may indicate the excessive accumulation of suspended materials in this area.

From the foregoing discussion, the following generalization can be made. The organic matter content in bottom sediment depends, primarily, on the supply of organic matter. The distribution of organic matter produced in the water or derived from lands is, however, not always projected directly to the sea bottom. It is largely controlled by environment of deposition. Organic matter precipitates in a combined state with suspended mineral particles, or suspended organic detritus tends to behave in a manner similar to that of finer fractions of the sediments, during the processes of transportation and deposition. Therefore, the distribution of the organic matter is greatly controlled by hydrodynamic condition, and is closely related to the particle size distribution of botton sediment. On the other hand, it is also greatly controlled by conditions which affect the preservation of organic matter. Namely the relative rate of deposition of nondecomposable detrital sediment controls partly the distribution of organic matter content in sediment. There is a greater possibility of preservation of organic matter in deposits which are accumulated at the optimum rates of deposition. With these points in mind, the causes of some of the differences in distribution of organic matter content in the sediment can be explained.

Organic acids in sediments

Biochemical oxidation of mumerous organic materials in sediments produces many metabolic products, including significant amounts of organic acids. The presence of organic acids in sediments and their relationship to sediment characteristics are of interest. The distribution of organic acids in sediment may indicate microbiological and biochemical characteristics of the environments. From this standpoint, the distribution of organic acids in marine and lake sediments were examined.

Identification and determination of organic acids in sediment samples from the sea off San'in district and lake Biwa were carried out by using chromatographic method (Mueller et al., 1958; Miyoshi et al., 1962), and the following results were obtained.

Lake Biwa: Vertical distribution of organic acids in bottom sediments of the location off Yanagasaki and off Otsu, and the related data are given in Tables 9~11. Sediment samples contained acetic, formic, lactic, propionic, butyric and unidentified organic acids, regardless of their depth from the surface of sediment. In the sediments off Yanagasaki, acetic acid was found in the highest concentration in the first 1.3 m from the surface of sediment, and formic acid was detected in the highest concentration below the depth of 1.8 m from the surface of sediment. The concentration of butyric acid increases with the depth from the surface of sediment. The percentage of this acid of total organic acids shows a downward increase which is slow for the first 2 m or so.

The area west of Oki Islands: The sampling locations are shown in Fig. 1. The data concerning the distribution of organic acids and the related data are shown in Tables 12 and 13. Sediment samples contained acetic, formic, lactic, propionic, butyric and unidentified organic acid, regardless of their origin. A lower concentration of butyric acid was found in the sediments of St. 19 and 20. The ratio of acetic acid to butyric acid was much higher in these sediments. It should be noted that the value of $\sigma\phi$ in these sediments is large in comparison with that of the sediments of other stations. In St. 17, a lower percentage of acetic acid, a higher percentage of formic acid, and the lowest value of the ratio of acetic acid to butyric acid were found. A higher percentage of formic acid was detected in the sediments of St. 22 and 23. From these data, it is considered that there are some differences in composition of organic acids in the sediments of the various location, in relation to the sediment characteristics and morphological features of the floor.

Summary

1) The sea off San'in district: Organic matter content is very low in the coarse sediments on the shelf. From shelf margin to slope, it increases progressively with depth, and with the increase of mud content of the sediment. On the banks and deep sea plain, low organic matter content was found.

Suruga Bay: Organic matter content is low in the coarse sediments of near-shore, and increases in the muddy area of offshore. In the east part of the bay, the content increases with depth, from the shore to the bottom of the "canyon" running along the Izu Peninsula, with the increase of mud content of the sediment. In the sediments of the bottom of the "canyon", the content is high and decreases towards the bay mouth in accordance with the decrease of mud content.

Tanabe Bay: Organic matter content was found to be high in the central and inner parts of the bay, and to become smaller in the outer part.

Osaka Bay: A high value of organic matter content was observed in the sediments off large cities, and a lower value in those of the central part.

2) The organic matter content is low in all types of bank sediments. Its content is low in nearshore coarse sediment, and increases rapidly in the area of muddy offshore. Organic matter content in the sediment of each depositional environment is closely related to the particle size distribution of bottom sediment. The sediment of high mud content contains abundant organic matter, except for the sediments of banks, of the area far offshore where deposition of detrital sediment seems to be very slow, and also of the area of too rapid deposition.

3) Since plenty of organic matter is accompanied with fine grained particles, its distribution is greatly controlled by hydrodynamic condition. It is also controlled by the depositional conditions which affect the preservation of organic matter, such as the rate of accumulation of detrital sediment, or the condition on and in the sediment. Hence, the features of distribution of organic matter in the sediments above stated, can be expalined with these points in mind.

4) Identification and determination of organic acids in sediment samples from the sea off San'in district and lake Biwa were carried out and the following results were obtained.

1. Sediment samples contain acetic, formic, lactic, propionic, butyric and unidentified organic acids, regardless of their origin and depth from the surface of sediment.

2. The concentration and composition of organic acids in the sediments of Lake Biwa vary with the depth from the surface of sediment. Among these, butyric acid increases with the depth from the surface of sediment.

3. There are some differences in composition of organic acids in the sediments of the various locations of the sea off San'in district.

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Table 1. Data concerning Series K Samples.

Sample number	N.	Lat.	E.	Long.	Depth in meters	Loss on ignition (per cent of dry sediment)	Kjeldahl-N (mg N/g, dry sediment)	Data concerning Particle Size Distribution* $M\phi$	$Md\phi$	$\sigma\phi$	$\alpha\phi$	% Sand	% Silt	% Clay	Character of bottom
K 1	37°	50.0′	136°	07.8′	600	10.1	2.81	5.10	4.95	2.90	0.05	43	41	16	
2	37	35.0	136	15.0	280	6.3	2.49	4.75	4.10	1.50	0.33	48	47	5	
3	37	25.9	136	02.8	500	9.4	2.19	4.60	2.95	2.45	0.67	65	25	10	
4	37	16.0	136	12.8	210										G.S
5	37	12.0	136	15.4	180	3.2	2.13	1.88	1.25	1.88	0.32	85	10	5	
6	37	15.0	135	24.1	554	5.5	2.01	4.65	3.53	2.35	0.48	62	24	14	
7	37	11.2	136	07.7	542	12.3	3.82	6.85	6.15	1.85	0.38	0	77	23	
8	37	01.0	135	54.4	520	13.7	4.10	6.87	6.67	2.14	0.09	10	67	23	
9	36	48.9	135	27.6	810	6.5	2.33	4.90	3.70	2.30	0.52	55	35	10	
10	36	45.3	135	50.3	731	12.0	3.95	6.75	6.50	1.75	0.14	8	74	18	
11	36	39.5	135	17.3	676	11.2	3.06	5.45	5.93	1.75	−0.24	18	72	10	
12	36	28.2	135	31.9	880	12.0	3.36	6.13	6.35	1.63	0.13	12	74	14	
13	36	23.4	135	59.6	85	5.1	2.21								Sh·MS·G
14	36	19.8	135	56.4	110	2.4	1.85	2.03	2.20	0.68	−0.25	100	0	0	
15	36	20.6	135	56.1	84	12.3	1.96								Sh·caAl
16	36	13.8	135	41.6	232	2.9	1.87	1.92	2.13	0.72	−0.29	100	0	0	
17	36	53.1	132	43.7	320	12.5	3.98	6.08	5.95	2.13	0.04	17	66	17	
18	35	56.7	132	43.8	185	10.4	2.52	5.20	4.33	2.65	0.33	46	39	15	
19	36	21.5	132	32.5	930	12.1	5.25	7.00	6.77	2.00	0.12	7	71	22	
20	36	11.6	132	36.7	490	10.9	3.78	5.55	6.05	2.55	−0.20	24	59	17	
21	36	35.5	132	37.2	1059	12.3	4.74	6.30	6.30	2.55	0.00	18	61	21	
22	36	41.3	132	30.5	1244	11.4	4.71	6.57	6.32	1.27	0.20	6	79	15	
23	36	27.5	132	30.0	1220	11.3	4.59	5.50	6.00	1.20	0.42	13	77	10	
24	36	54.1	134	44.2	317		1.65	2.23	2.39	1.18	−0.51	91	9	0	
25	37	03.8	135	00.5	568		2.03	3.08	2.63	1.18	−0.89	83	15	2	

* Calculated from SATO's data (1964).

Table 2. Data concerning Series M and T Samples.

Sample number	N.	Lat.	E.	Long.	Depth (M)	Water content (per cent of wet sediment)	Loss on ignition (per cent of dry sediment)	Kjeldahl-N (mg N/g, dry sediment)	Data concerningParticle Size Distribution ϕ_5	ϕ_{16}	ϕ_{25}	ϕ_{50}	ϕ_{75}	ϕ_{84}	ϕ_{95}	% Sand	% Silt	% Clay
M 1	36	24.0	135	04.5	480	65.67	12.28	5.58	4.60	5.87	6.54	8.02	(10.05)			2	47	51
M 2	36	20.5	135	06.2	390	71.92	11.00	5.71	5.17	5.99	6.52	7.96	(10.50)			4	47	49
M 3	36	04.3	135	12.0	310	61.91	13.97	4.53	4.30	5.64	6.03	7.42	9.10			4	55	41
M 4	35	54.9	135	14.5	200	45.95	10.26	3.06		−0.28	1.07	4.37	8.05			49	26	25
T 1	37	10.7	132	18.7	185		3.42	2.11	0.78	1.26	1.41	1.82	2.38	2.74	4.50	93	4	2
T 2	37	10.0	132	03.8	165		6.76	1.85	0.30	1.31	1.60	1.83	2.29	2.61	4.10	94	3	2
T 3	37	36.4	132	54.3	390		14.85	4.65	2.74	4.06	4.46	4.97	5.78	6.59		15	74	11
T 4	37	11.8	132	46.0	315		14.59	4.17	2.47	3.60	4.33	5.56	6.96	7.75		20	66	14
T 5	35	56.9	131	31.5	600		4.34	2.11		1.11	1.46	2.17	2.66	2.97	4.70	85	5	2

Note: The percentage of gravels is not indicated here, because it is easy to calculate it by subtracting from 100% the percentage of the sediments tabulated.

Table 3. Data concerning Series D samples.

Sample No.	Depth (M)	Loss on* ignition (%)	Kjeldahl-N* (mg N/g)	Particle size measures									
				ϕ_5	ϕ_{16}	ϕ_{25}	ϕ_{50}	ϕ_{75}	ϕ_{84}	ϕ_{95}	% Sand	% Silt	% Clay
1- 2	20	1.94	1.48	2.90	3.20	3.30	3.60	3.90	4.16	5.60	80	20	0
3	29		1.54	2.86	3.19	3.26	3.51	3.80	4.05	4.94	83	15	2
4	40		0.44	−0.56	−0.26	−0.06	0.51	1.10	1.36	1.88	97	1	0
5	50		0.53	−1.14	−0.34	0.05	0.79	1.49	1.89	2.90	94	0	0
6	62		0.41	−0.54	0.11	0.46	1.18	1.69	1.86	2.26	98	0	0
7	68		0.47	0.39	0.94	1.23	2.00	2.50	2.70	2.97	99	1	0
8	77		0.37	−1.42	0.14	0.58	1.04	1.42	1.64	2.46	90	0	0
9	78		0.42	−0.95	−0.14	0.30	1.18	1.82	1.93	—	95	0	0
10	84		0.47	0.40	1.07	1.32	1.99	2.40	2.56	2.81	100	0	0
11	140	9.10	2.44	1.69	2.25	2.50	3.31	4.59	5.42	8.30	67	27	6
13	150		3.68	4.56	5.39	5.74	6.90	8.52	9.46	11.22	2	66	32
15	160		2.98	3.46	4.18	4.50	6.13	7.02	7.99	—	11	73	16
16	154		2.46	3.76	4.36	4.71	5.50	6.95	7.96	10.05	8	76	16
18**	116		0.94	1.21	1.91	2.39	3.42	4.28	4.70	6.86	67	30	3
19****	44		0.73										
2- 1	57		0.48	−1.32	−0.97	−0.68	0.07	0.99	1.37	2.20	85	0	0
2	65			−2.30	−0.27	0.22	1.24	1.97	2.14	2.50	91	0	0
3	78		0.43	−0.32	0.21	0.49	1.09	1.66	1.89	2.36	99	0	0
4	86		0.44	−0.02	0.54	0.88	1.60	2.22	2.41	2.67	99	0	0
5	98		0.46	−0.12	0.65	1.10	2.16	2.40	2.50	2.77	99	1	0
6	118		0.52	0.45	0.99	1.42	2.28	2.50	2.62	2.91	99	1	0
7	141		1.68	0.90	2.18	2.47	2.70	2.84	3.12	4.49	91	9	0
8	202	8.87	2.51	2.32	2.60	2.82	3.92	5.85	6.70	—	52	40	8
9	209	11.78	3.59	2.50	3.30	3.92	4.88	6.12	6.99	9.20	26	65	9
10	209		3.68	3.32	4.57	4.80	5.36	6.67	7.51	8.68	8	80	12
3- 1	18		0.49	1.57	1.56	2.34	2.65	2.87	2.97	3.37	100	0	0
2	36				−0.12	0.34	0.88	1.31	1.50	2.05	88	0	0
3****	43												
4	54		0.46	−1.50	0.23	0.41	0.67	0.89	1.13	1.91	94	0	0
5	66		0.40	−0.42	0.37	0.70	1.39	1.98	2.21	2.64	99	0	0
6	72		0.37	−0.13	0.60	0.85	1.40	1.91	2.09	2.48	99	0	0
7	78		0.44	−0.92	0.14	0.51	1.21	1.74	2.01	2.38	95	1	0
8	95		0.43	−0.04	0.67	0.93	1.63	2.30	2.55	2.90	100	0	0
9	106		0.48	−0.14	0.78	0.78	1.67	2.39	2.58	2.82	100	0	0
11	174		1.14		0.00	0.38	2.36	2.74	2.90	6.85	90	7	3
12	236		2.24	2.48	3.05	3.30	3.90	5.32	5.92	9.20	53	39	8
13	320	3.78	2.07	4.42	4.72	4.88	5.52	6.63	7.25	—	2	88	10
15	458	5.12	1.86	0.05	0.70	1.30	4.50	5.80	6.82	10.00	39	52	9
4- 1***	74		0.95										
2***	97		1.13										
3***	130		0.90										
4**	154		1.23	1.63	2.46	2.88	3.51	3.86	3.99	4.61	85	15	0
5	181	6.22	2.19	2.37	2.81	3.00	3.51	4.03	4.56	6.70	75	22	3
6	214	11.73	3.56	2.65	4.07	4.47	5.18	6.36	6.97	9.80	15	75	10
7	222		2.52	2.50	2.96	3.23	4.05	5.10	6.48	9.40	49	42	9
8	388		2.64	2.89	3.45	3.45	4.05	5.21	6.36	9.10	49	42	9
9	382		2.87	3.21	4.00	4.38	5.36	7.70	8.55	—	16	65	19

*Calculated against dry sediment. **S·Sh ***Sh ****G·Sh

Note: The percentage of gravel is not indicated here, because it is easy to calculate it by subtracting from 100% the total paercentage of the sediments tabulated.

Table 4. Data concerning the Sediments of Suruga Bay.

Station number	N.	Lat.	E.	Long.	Depth in meters	Water content (per cent of wet sediment)	Loss on ignition (per cent of dry sediment)	COD (O_2 consumed mg/g, dry sediment)	Kjeldahl-N (mg N/g, dry sediment)	Character of bottom	Sampling date
TSC 1	34°	44.9′	138°	22.0′	498	46.3	5.2	15.5	2.37	M	March 23, 1965
2	34	42.9	138	17.7	52	30.8	3.9	6.6	1.66	M	”
3	34	42.85	138	15.7	22	25.2	2.9	1.6	1.05	f.S	”
4	34	42.8	138	25.2	735	48.9	6.0		2.81*	M.G	”
5	34	49.9	138	26.95	910	44.4	4.9	11.6	2.05	M.S	March 24, 1965
6	34	49.1	138	38.0	1650	64.3	6.0	17.4	2.85	M	”
7	34	54.5	138	38.0	1565	62.3	6.0	23.6	3.01	M	”
9	35	01.6	138	45.4	465	62.7	10.6	29.4	3.32	M	March 25, 1965
10D	34	43.1	138	43.4	140	31.6	5.5	6.3	1.10	f.S	”
11	34	42.4	138	33.9	1580	55.7	6.9	12.9	2.07	M	March 29, 1965
12	34	42.8	138	36.4	1735	46.9	4.5	13.5	1.53	M	”
14D	34	42.9	138	41.4	360	45.2	8.3	14.2	2.31	M	”
15	34	42.8	138	18.3	192	46.7	5.5		2.77	M.S	March 30, 1965
16	34	35.6	138	34.8	2550					c.S	June 9, 1965
17	34	53.3	138	34.7	850	50.0	6.3	15.1	2.27	M	June 10, 1965
18	35	02.5	138	40.2	920					c.S	June 11, 1965
TSD 1	34	38.6	138	30.45	215					G	March 23, 1965
2	34	38.9	138	28.7	84	26.9	5.0	8.2	1.79	M	”
2′						15.0*	4.1*	6.5*	1.26*	M·S·G	”
3	34	43.9	138	30.8	68	3.8*	2.2*	1.0*	0.43*	S.G	March 30, 1965
4	34	43.95	138	28.2	392	55.6	6.1	17.5	2.73	M	”
5	34	42.1	138	36.7	1600	46.9	5.4	9.0	2.70	M	June 9, 1965
6	34	43.2	138	32.1	400–300					R	”
7	34	30.7	138	20.2	52					S.G	”
8	34	29.9	138	23.2	222–180	35.2	5.4	8.5	2.05	M	”
9	34	45.5	138	42.9	250	42.9	9.4	14.4	1.98*	M.S	June 10, 1965
10	34	44.4	138	40.3	553	39.5	7.6	13.7	1.22*	M.S	”
11	34	53.7	138	30.2	450–370	29.7	4.0	7.3	1.67*	M.G	”
12	34	55.0	138	30.0	130–120	23.4	3.6	3.6	1.34	M	”
13	34	55.0	138	29.0	70	28.5	3.4	5.4	1.52	f.S	”
14	34	53.2	138	30.5	270	43.9	5.9	10.6	1.87	M	”
15	35	03.1	138	48.3	145	27.9	4.8	6.4	1.16*	M.G	June 11, 1965
16	35	02.4	138	49.6	120	38.1	7.6	13.8	1.69*	M.G	”
17	35	58.0	138	32.5	190	30.6	4.1	9.7	1.75*	M.G	“
TSB 2	35	04.8	138	46.95	515–486	62.1	9.9	26.5	3.36	M	March 28, 1965
	35	04.5	138	47.2							
4	34	47.3	138	37.8	1740	50.9	5.0	12.3	2.39	M	March 29, 1965
	34	47.8	138	37.6							

*Fraction finer than -1ϕ was examined.

Table 5. Vertical distribution of water content, loss on ignition, Kjeldahl-N and Mdϕ in bottom sediments of Suruga Bay.

Water content* (%) Core depth (cm)	Station number TSC 1	TSC 6	TSC 9	TSC 11	TSC 12	TSD 5
0– 5	46.3	64.3		55.7	46.9	46.9
5– 7			62.7	54.9	40.2	
7– 9				59.1		41.6
9–13				51.8		
10–15	46.7	58.9				
20–25	39.9	63.0				
30–35	34.2					
55–60			53.7			

*Calculated against wet sediment.

Loss on ignition* (%) Core depth (cm)	Station number TSC 1	TSC 6	TSC 9	TSC 11	TSC 12	TSD 5
0– 5	5.2	6.0		6.9	4.5	5.4
5– 7			10.6	5.8	5.4	
7– 9				6.7		5.3
9–13				6.7		
10–15	5.0	6.8				
20–25	5.1	6.8				
30–35	4.6					
55–60			9.1			

*Calculated against dry sediment.

Kjeldahl-N* (mg N/g) Core depth (cm)	Station number TSC 1	TSC 6	TSC 9	TSC 11	TSC 12	TSD 5
0– 5	2.37	2.85	9.20	2.07	1.53	2.70
5– 7			3.32	2.28	1.87	
7– 9				3.01		1.77
9–11				2.29		
5–10		2.80				
10–15	2.23	2.97				
15–17		2.63				
17–20		2.59				
20–25	2.18	3.87				
30–35	1.93	2.20				
55–60			1.47			

*Calculated against dry sediment.

Mdϕ Core depth (cm)	Station number TSC 6	TSC 11	TSC 12	TSD 5
0– 5	7.28	5.48	5.10	6.07
5– 7		6.50	6.53	4.65
7– 9		6.02		4.95
9–11		6.90		
5–10	6.78			
10–15	7.70			
15–20	7.41			
20–25	7.76			
25–30	6.90			

Table 6. Data concerning the Sediments of Tanabe Bay (August, 1965).

Station number	Depth (M)	Water content (per cent of wet sediment)	Loss on ignition (per cent of dry sedimnet)	Kjeldahl-N (mg N/g, dry sediment)	Data concerning Particle Size Distribution												
					ϕ_5	ϕ_{16}	ϕ_{25}	ϕ_{50}	ϕ_{75}	ϕ_{84}	ϕ_{95}	M_ϕ	σ_ϕ	α_ϕ	% Sand	% Silt	% Clay
TB 1	43	26.15	5.09	1.38	1.00	1.95	2.34	3.07	3.65	4.17	7.50	3.06	1.11	−0.01	82	14	4
2	33	35.34	6.06	1.61	1.41	2.20	2.52	3.20	3.88	6.00	9.19	4.10	1.90	0.47	77	16	7
4	16	40.97	7.60	2.35	3.50	4.40	4.76	6.00	8.08	9.40	—	6.90	2.50	0.36	8	67	25
5	22	41.22	7.74	1.23	3.52	4.44	4.84	6.16	8.80	9.17	—	6.81	2.37	0.27	9	66	34
6	15	45.79	7.78	2.33	3.30	4.45	4.90	6.15	7.86	8.70	—	6.58	2.13	0.20	10	67	23
7	13	44.39	7.66	2.38	4.08	5.18	5.85	7.10	10.62	12.87	—	9.03	3.85	0.50	4	57	39
8	11	43.47	6.26	2.11	3.07	4.10	4.60	6.00	8.05	9.72	—	6.91	2.81	0.32	15	60	25
9	11	32.59	6.69	1.69	2.47	3.69	4.05	4.74	6.53	7.96	—	5.83	2.14	0.51	24	60	16
12	26	30.14	6.72	1.68		1.60	2.12	3.21	4.78	6.40	—	4.00	2.40	0.32	66	25	9
15*	41	14.05	4.40	0.51													
16*	33	26.14	3.00	0.55													
17	24	30.41	6.86	0.71	−0.03	1.43	2.21	3.85	5.56	7.10	—	4.27	2.84	0.15	53	36	11
18	15	28.21	8.55	0.69	1.85	2.78	3.12	3.66	4.04	4.58	8.72	3.68	0.90	0.02	74	19	7
19	15	26.71	5.73	1.29	0.50	2.70	3.00	3.45	3.90	4.30	6.50	3.50	0.80	0.06	76	18	4
20*	47	27.09	2.86	0.02													
21**																	
22	11	25.48	4.71	1.26	0.69	2.40	3.10	3.65	4.26	4.98	8.31	3.69	1.29	0.03	70	23	6
23	20	27.95	5.03	1.47	3.21	3.70	3.90	4.31	4.92	5.87	9.83	4.79	1.09	0.44	28	63	9
24	26	28.12	7.64	1.50	−0.58	0.97	1.58	3.11	4.59	6.09	—	3.53	2.56	0.16	68	24	8
25	8	30.72	3.33	1.17	1.53	2.3	2.52	2.80	3.20	3.50	4.27	2.90	0.60	0.17	93	6	1

Note: The percentage of gravel is not indicated here, because it is easy to calculate it by subtracting from 100% the total percentage of the sediments tabulated.

* sand

** gravel

Table 7. Data concerning the sediments of Osaka Bay (August, 1965).

Station number	N.	Lat.	E.	Long.	Depth in meters	Water content (per cent of wet sediment)	Loss on ignition (per cent of dry sediment)	Kjeldahl-N (mg N/g, dry sediment)	Character of bottom
S 1	34°	36.48′	135°	12.50′	17	63.2	9.7	3.21	mud
2	34	37.54	135	14.27	16	81.9	10.1	7.09	mud
3	34	38.35	135	15.45	16	60.9	9.6	2.97	mud
4	34	39.03	135	16.58	14.6	72.5	11.1	3.89	mud
5	34	40.27	135	18.32	13	72.4	12.6	3.14	mud
6	34	38.36	135	18.40	14.6	71.8	12.5	3.90	mud
7	34	36.86	135	18.46	16	74.4	11.0	4.33	mud
8	34	35.62	134	17.30	17	67.2	10.7	3.77	mud
9	34	34.31	134	15.77	18	84.4	10.0	8.54	mud
10	34	33.64	134	15.00	19	60.9	10.3	2.95	mud
11	34	32.92	134	13.78	20	60.2	9.8	2.84	mud
12	34	30.22	134	12.34	25	59.1	9.9	3.47	mud
13	34	28.07	134	10.00	31	63.0	9.8	3.79	mud
14	34	29.55	134	08.20	36	29.8	10.1	1.25	mud
15	34	31.45	134	06.42	32				gravel
16	34	31.58	134	06.05	33				gravel
17	34	27.27	134	13.13	21	57.0	9.0	2.79	mud
18	34	25.42	134	14.30	18	58.1	10.7	3.00	mud
19	34	27.25	134	16.21	18	63.4	9.2	3.84	mud
20	34	28.50	134	18.11	16	66.9	10.0	4.10	mud
21	34	30.85	134	19.47	15	66.7	11.8	4.18	mud
22	34	31.85	134	20.90	14.6	70.7	11.9	4.28	mud

Table 9. Vertical distribution of organic acids in bottom sediments in Lake Biwa.

Organic acid	Sediments off Yanagasaki (July, 1963) Core depth (cm)					Sediments off Otsu (Nov., 1963)* Core depth (cm)	
	29–31	129–131	179–181	239–241	289–291	469–471	559–561
Butyric	0.02	0.04	0.08	0.20	0.31	0.02	0.06
Propionic	0.69	0.23	0.87	0.66	1.42	0.12	0.29
Acetic	5.50	4.09	5.45	3.75	4.19	3.35	2.06
Pyruvic	0	0	0	0	0.05	0	0
Formic	3.61	2.16	7.68	4.57	5.13	0.70	0.94
Lactic	0.16	0.65	1.17	0.78	1.32	—	0.20

Results are expressed as μe/g dry sediment.
*Results are expressed as μe/g wet sediment.
Depth of overlying water: 5 m.

Table 10. Data concerning the bottom sediments of Lake Biwa (Sept., 1962).
Sediments off Yanagasaki (water depth: 5 m)

Core depth (cm)	Water content* (%)	COD** (mg O_2 consumed/g)	Kjeldahl-N** (mg N/g)	Loss on ignition** (%)	Acid Soluble ferric iron* (mg/g)	Acid soluble total iron* (mg/g)	% Sand	% Silt	% Caly
29– 31	53.9	32.5	3.18	9.1	1.10	23.50	24	60	16
129–131	38.4	25.1	2.20	6.5	1.45	18.75	22	69	9
179–181	52.0	74.7	4.22	14.2	0.90	15.00	9	51	40
239–241	36.2	46.3	2.47	9.3	1.15	18.75	19	45	36
289–291	35.6	27.4	2.19	8.3	1.22	17.50	1	49	50

* Calculated against wet sediment.
**Calculated against dry sediment.

Table 8. Vertical distribution of water content, loss on ignition, and Kjeldahl-N in bottom sediments of Osaka Bay (August, 1965).

Water content* (%) Core depth (cm)	Station number S 1	S 3	S 5	S 7	S 10	S 13	S 18	S 20	S 22
0– 5	63.2	60.9	72.4	74.4	60.9	63.0	58.1	66.9	70.7
5– 10								52.5	54.4
40– 45				52.1		47.7			
45– 50					48.3		51.2		
50– 55		45.4	53.3					50.8	52.7
70– 75			53.3	50.3					
80– 85						45.2			52.5
85– 90							50.4		
90– 95				43.2		41.7		52.1	
100–105							51.6		50.1
120–125									50.8
185–190	41.9								

* Calculated against wet sediment.

Loss on ignition* (%) Core depth (cm)	Station number S 1	S 3	S 5	S 7	S 10	S 13	S 18	S 20	S 22
0– 5	9.7	9.6	12.6	11.0	10.3	9.8	10.7	10.0	11.9
5– 10								9.0	8.4
40– 45				6.0		7.0			
45– 50					7.1		8.5		
50– 55		5.9	7.8					8.2	8.1
70– 75			9.6	8.1					
80– 85						5.3			8.1
85– 90							8.1		
90– 95				7.5		8.4		7.9	
100–105							8.9		8.7
120–125									10.2
185–190	7.6								

* Calculated against dry sediment.

Kjeldahl-N* (mg N/g) Core depth (cm)	Station number S 1	S 3	S 5	S 7	S 10	S 13	S 18	S 20	S 22
0– 5	3.21	2.97	3.14	4.33	2.95	2.79	3.00	4.10	4.28
5– 10								2.63	2.75
40– 45				2.36		2.35			
45– 50					2.21		2.78		
50– 55		2.15	2.51					2.25	2.61
70– 75	1.89		2.69	2.59					
80– 85						2.53			2.34
85– 90							2.24		
90– 95				1.60		1.92		2.59	
100–105							2.45		2.45
120–125									2.77
185–190	2.09								

* Calculated against dry sediment.

Table 11. Vertical distribution of water content and Kjeldahl-N in bottom sediments* of Lake Biwa (Sept., 1963).

Core depth (cm)	Water content** (%)	Kjeldahl-N*** (mg N/g)	Sediment type
10	54.2	3.19	mud
20	55.5	3.54	mud
30	53.9	3.18	mud
40	49.4	3.18	mud
50	47.8	2.93	mud
60	46.9	3.26	mud
70	17.4	1.14	muddy sand
80	26.1	1.15	medium sand
90	27.7	1.62	fine sand
100	27.9	1.63	medium sand
110	29.1	1.80	muddy sand
120	37.5	2.64	silt
130	38.4	2.20	silt
140	52.9	4.68	mud
150	24.5	1.36	fine sand
160	56.9	5.27	mud
170	58.4	5.80	mud
180	52.0	4.22	mud
190	26.5	1.62	muddy sand
200	25.1	1.68	muddy sand
210	54.8	4.75	mud
220	43.1	3.01	mud
230	35.3	2.46	mud
240	36.2	2.47	mud
250	25.0	1.91	mud
260	27.2	1.77	mud
270	20.6	1.54	sandy mud
280	20.3	1.53	sandy mud
290	35.6	2.19	mud
300	27.0	1.82	mud
310	21.4	1.50	sandy mud

* Sediments off Yanagasaki (depth of overlying water: 5 m).
** Calculated against wet sediment.
*** Calculated against dry sediment.

Table 12. Amounts* of organic acids in bottom sediments off San'in District (July, 1962).

Sample No.	Depth (m)	Butyric	Propionic	Acetic	Pyruvic	Formic	Lactic
K-17	320	0.47	1.20	7.39	0.47	10.07	0.45
91	930	0.11	0.94	10.69	0	6.09	0.73
20	490	0.07	0.73	8.44	0.16	4.32	0.67
21	1059	0.74	2.71	16.87	0.28	11.08	1.49
22	1244	0.56	0.62	10.45	0.17	3.97	1.21
23	1220	0.65	1.50	18.54	0	6.86	1.09

* Expressed as $\mu e/g$ dry sediment.

The sampling locations are shown in Fig. 1, and listed in Table 13.

Table 13. Distribution of water content, COD and Kjeldahl-N in bottom sediments off San'in District (July, 1962).

Sample No.	N.	Lat.	E.	Long.	Depth (M)	Water content* (%)	COD** (mg O_2 consumed/g)	Kjeldahl-N** (mg N/g)	Loss on ignition** (%)	$Md\phi$	$\sigma\phi$	% Sand	% Silt	% Clay
K-17	36°	53.1′	132°	43.7′	320	55.5	31.9	3.98	12.5	7.50	1.41	10	44	45
18	35	56.7	132	43.8	185	45.0	15.5	2.52	10.4	4.33	2.65	46	39	15
19	36	21.5	132	32.5	930	62.5	42.1	5.25	12.1	8.84	2.47	2	34	64
20	36	11.6	132	36.7	490	53.1	35.4	3.78	10.9	7.38	3.07	18	40	42
21	36	35.5	132	37.2	1059	53.8	37.6	4.74	12.3	8.31	1.92	1	44	55
22	36	41.3	132	30.5	1244	61.8	46.6	4.71	12.3	8.80	1.69	1	32	67
23	36	27.5	132	30.0	1220	61.4	40.9	4.59	11.3	8.47	1.81	2	39	59

* Calculated against wet sediment.

** Calculated against dry sediment.